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The Degree of Visibility as a Tool to Assess and Design of a Visual Corridor

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Introduction

Visual analysis has permanently entered the procedures related to design and management of spatial resources. It is strengthened in the form of instructions and textbooks and hence has become a vital source of information for more conscious design of spatial effects. The basis of the visual analyses is the range of the view - called *viewshed*. It used to be marked out with a ruler and a topographic map (Felleman, 1986) while currently this process is conducted with digital tools (Bishop, 2007). In this way we gain information regarding the range of the view from a particular site and hence the area from which the site is visible. This information refers to the surface and it contains the data on the area of the visible field called ZVI-*Zone of Visual Influence* used interchangeably with another term: ZTI, i.e. *Zone of Theoretical Visibility* or *Zone of Visual Impact*. When the subject of the analysis becomes a road stretched in the space, the river route or the power line we are dealing with a linear element. The visual zone in the traditional sense provides us only with partial information about the visual impact of the lines and lies far from the real visual relation between the line and the shape of the space it goes through. The line as a complex element requires an individual approach that takes into account its character.

Visual area

Studies of the visual area go back far in time. They were already applied in Defence Architecture in the 19th century. In mid 20th century applying those studies became a widespread practice (Litton, 1973; Flagorowska, 1981; Smardon et al., 1986) and at that time they were called *Visual Envelope Mapping* (VEM). Development of digital tools was followed by a growth of the range, scale and precision of mapping visual area which were known as *Viewshed* and *Viewshed Analysis* (Bureau of Land Management, 2012). Nowadays, they are used as studies of the visual impact assessment and have become a permanent part of procedures related to management of visual resources as well as the evaluation of visual impact (GLVIA 2002, 2013, GVIA of Highway Project 1988). Apart from the surface analyses in the form of viewshed range this issue is developed in studies. The topic of dynamic perception of landscape and visual enclosures was the author's doctor's thesis between 2003 and 2005 (Forczek-Brataniec, 2008). In the latest issue of GLVIA for Highway Projects the term *dynamic viewshed* appeared to describe a series of static visual fields from selected representative points (GVIA of Highway Project 2015). Multipoint visual analyses are developed consecutively. They mainly deal with the impact of wind towers and stratification of data over quantitative spheres. The method of studying visual field of a mobile point is worth noticing in the group of complex analyses (Ozimek, 2003). Development of digital tools makes it possible for multipoint analyses to be applied more frequently than previously. Studies of this issue are dispersed and mainly concern specific situations and precise study assignments.

Line visibility area

The topic of this study was a line in the landscape. The line was understood in two different ways, both as an object seen from outside and an object from which the view is seen.The line was recognized as a complex multipoint structure comprising numerous points, each of them having its own visibility area. The aim of this study was to define the characteristics of the line element resulting from its complex structure as well as the impact of these characteristics on the visual area. Hence, the examination of those characteristics in detail and putting the study results in order. Exploration of the objectives aimed at finding accuracy as well as indicating the method of presenting the results and possibilities of their application when solving real design problems related to linear forms in the landscape.

Model and its application

This paper undertakes the method of studying the issue on a simplified model and then testing it in a selected spatial situation. For the study purposes we created a model of not unified surface fitted with three cameras for observation. A line made of points went through the model. Taking advantage of possibilities of digital space, lines of various placement and different gradeline were examined. The results were applied in the case study on the design of the visual corridor. The topic referred to a section of a scenic road on the natural park grounds. The assignment was to correct the surroundings of the roadside, which was to enhance the visual values decreased as a result of the progressing natural succession.

Effects of the analysis of the line visibility area- degree of visibility

Model

Treating the line as a complex element opened up a new sphere of experience. The line is made of points and every one of them has its own visibility area. The line has become a multi-element structure with the multi-layer visibility area. Since every point has a slightly different location the borders of its viewshed are different. As a result, the visibility area is of different thickness depending on the number of layers placed on each other. The number of layers in a given terrain depends on the number of line points from which the terrain is visible. As a result, the bigger stratification in a given terrain, the longer road section is visually related to it. The obtained structure is put in the right order in accordance with the applicable thresholds, similarly to other phenomena. This technique allowed for division of the visibility field in accordance with the degree of stratification into visibility degrees (VD). It was assumed that the highest degree of visibility - 5 VD means that the zone is visible from all line points, whereas the lowest degree of visibility - 0 VD means that the zone is not visible from any line points. The mid degrees define the line part from which a given zone is visible. The obtained data, while presented in the form of calculations, gives the possibility for interpretation with use of diagrams. The degree of visibility outlined the structure of the already known borders of the visibility area while deepening the knowledge of the realistic visual properties of the line form (Fig.1). The model analysis created a graphic, calculation, and conceptual framework for the issue which, during the later phase of the study, was tested while examining the changes of line location as well as changes in its gradeline (Fig.2). Comparison of the data confirmed the accuracy of the graphic and numeric value which ensured that interpretation of differences and comparison is easily readable. The adopted method of analysis of the visual corridor brought about one more intriguing effect. With use of stratification of visibility areas a precise division into visual interiors was also made possible. Thanks to it, it became possible to indicate their zone and line points belonging to them (Fig.3). As a result, we also succeeded in studying variability of these interiors depending on the changes in line course.

Case study

The tools gained as a result of work on the model were applied to the realistic example. For this project a visual road section in the Bieszczady National Park was studied. The progressing natural succession decreased the visual values of the road. The question arose whether the greenery shading the surroundings should be removed and if yes then which greenery sections should be removed in order to achieve the best visual effects. The maintenance measures were to focus on clearing away the overgrowth and regular maintenance in the future. The activities required outstanding precision and consciousness due to the fact that they dealt with protected terrain.

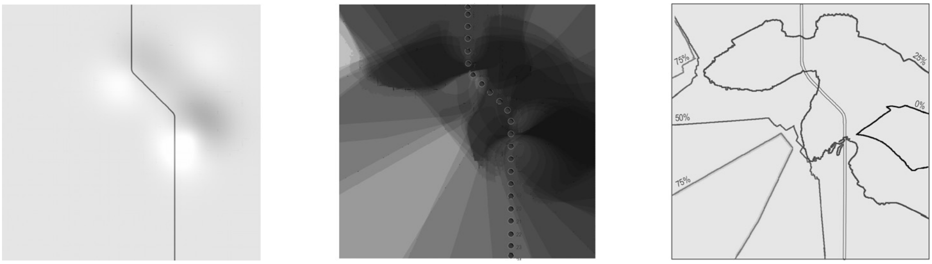


Figure 1. Model. An analysis of the line treated as a form made of points. A division of multi-layered visibility area into degrees

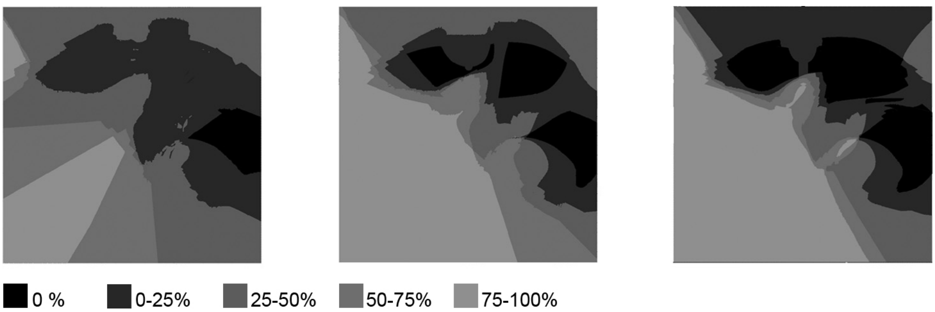


Figure 2. Comparison of degree of visibility of lines of various course and various gradeline

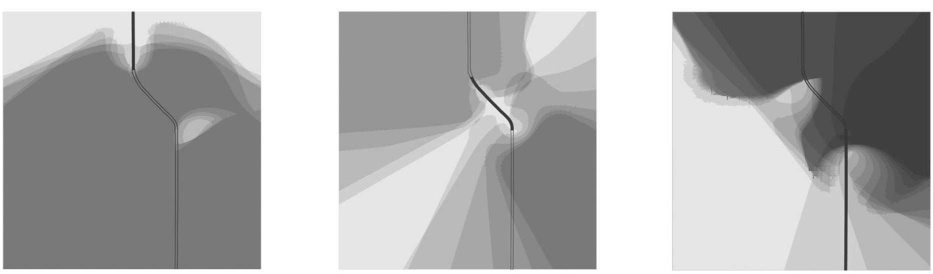
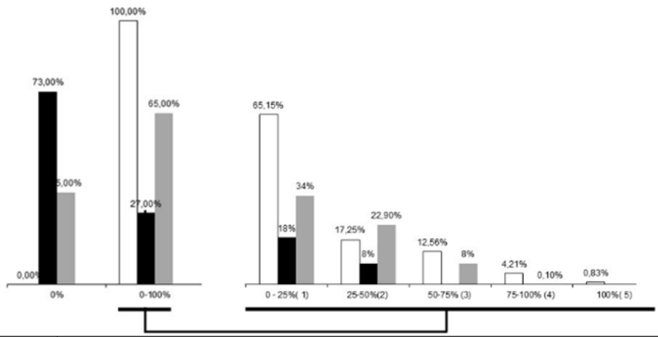


Figure 3. Division into visibility enclosures based on the structure of visibility area

In order to answer the question we used the study of degree of visibility which was carried out in three options. In the first option we studied maximum exposure possibilities available taking into account the terrain configuration. The second option described the situation in which greenery develops freely. The third one took into account removing the greenery on selected sections of the roadside.

The visibility field, traditionally understood as a one-dimensional area, has changed depending on the applied action scenario. When the changes in its range were compared the following data was obtained. When it was assumed that the maximum viewshed range obtained and defined with land surface is 100 per cent, it turned out that in case of no intervention and free succession growth its surface will take 27 per cent, whereas in case of clearing the area it will take 65 per cent. Marking the degrees of visibility gave us additional information. We received data on the way the exposure levers are distributed and what road sections it is related to (Tab.1).

Table 1. Comparison of visibility area and degree of visibility for the three alternatives in the analysis



		Degree of Visibility				
option	VD 0	VD 1	VD 2	VD 3	VD 4	VD 5
O1	-	**65 %** 29.96	**17%** 7.59	**13 %** 5.13	**4 %** 1.14	**1%** 0.06
O2	**73 %** 33.92	**18 %** 8.62	**8 %** 3.41	**1 %** 0.93	-	-
O3	**35 %** 16.24	**34 %** 15.15	**22. %** 10.66	**8 %** 3.25	**0. %** 0.58	

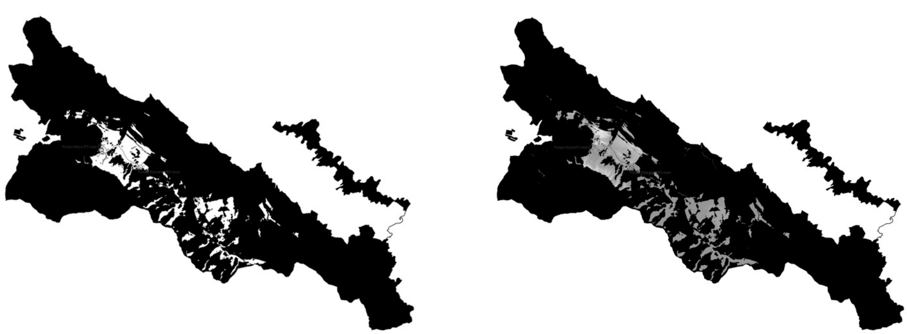


Figure 4. Option 3. On the left the data on the visibility area; on the right the data on the degree of visibility

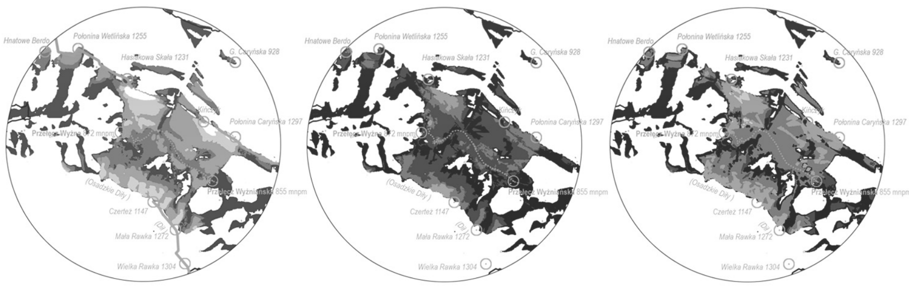


Figure 5. Illustration of changes in the degree of visibility of the Bieszczady połoniny. From left: option 1 maximum visibility abilities of the terrain; option 2 assuming development of natural succession; option 3 the state after clearing the roadside surroundings

Figure 6. View of the połoniny in the Bieszczady National Park

The role and informative value of the division into degrees of visibility might be explained when we go through the changes in exposure of the Bieszczady peaks: Wetlinska and Carynska Poloniny, the most attractive landmarks seen from the road. Theoretical exposure abilities of the Poloniny are significant. Option 1: thanks to the study of the degree of visibility it might be stated that lack of trees nearby the roadside is a guarantee of visibility of the Poloniny ridges from the entire analysed road section (5 VD). The leading visual element of this road section: the peak of Wetlinska Polonina would be visible from over a half of its length (3 VD). Option 2: the moment we allow for free growth of the road corridor the Poloniny ridges will be visible from the part constituting less than a half of the road section (2 VD), whereas the Peak of Wetlinska Polonina is bound to vanish from the visibility area (0 VD).

Option 3: maintenance measures in the form of removing the bushes from the direct proximity of the roadside mean the parameters are bound to increase significantly. The Poloniny ridges are going to increase exposure of one degree (they will reach 3 VD). Therefore, they will be visible from over a half of the road and the peak of Wetlinska Polonina will appear for at least a quarter of the road (2 VD). This data would be unavailable without the tool in the form of degree of visibility. A comparison of one-dimensional visibility fields would point at insignificant changes in their range which would not present the real impact of the progressing succession or intervention activities. Therefore, this would not provide us with enough knowledge on real benefits resulting from maintenance of the road surroundings. As a result, it leads to optimalization of the results, that is the selection of the best effect gained at lowest possible cost.

Studying the degree of visibility is also applied in case of designing new roads. Its effectiveness was tested with the evaluation of the course alternatives for a new road nearby a historic monastery. The results also proved useful both in terms of estimating the impact on the surrounding landscape and the landscaping the view from the road.

Benefits and abilities for application of the Degree of Visibility studies

The presented method of the examining degree of visibility is widening the range of information on the visibility values of the line element. It also refers to the impact of the linear object onto the surrounding landscape as well as to shaping the landscape seen from it. It makes the knowledge on the visibility field of the visual corridor comprehensive. It singles out the structure and distribution from the visibility field. It goes deep inside the issue while presenting the appropriate characteristics dedicated to the characteristics of the object under analysis.

A clear and unambiguous record of the issue in the graphic and calculative form facilitates interpretation of the results. Making use of the "degree" term, similarly to other phenomena (noise or light), puts it in the right order and opens up a wide field of application. The presented method supplements and develops the study recommended in the generally applicable guidelines and manuals for preparing visual impact assessment. It is consistent with both the British GLVIA and the American VRMS. A direct possibility of application is found in the instructions related to the linear forms, such as: GLVIA for Highways Projects since it is a significant development of the issue of "dynamic viewsheds" while defining the area of visual effect.

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